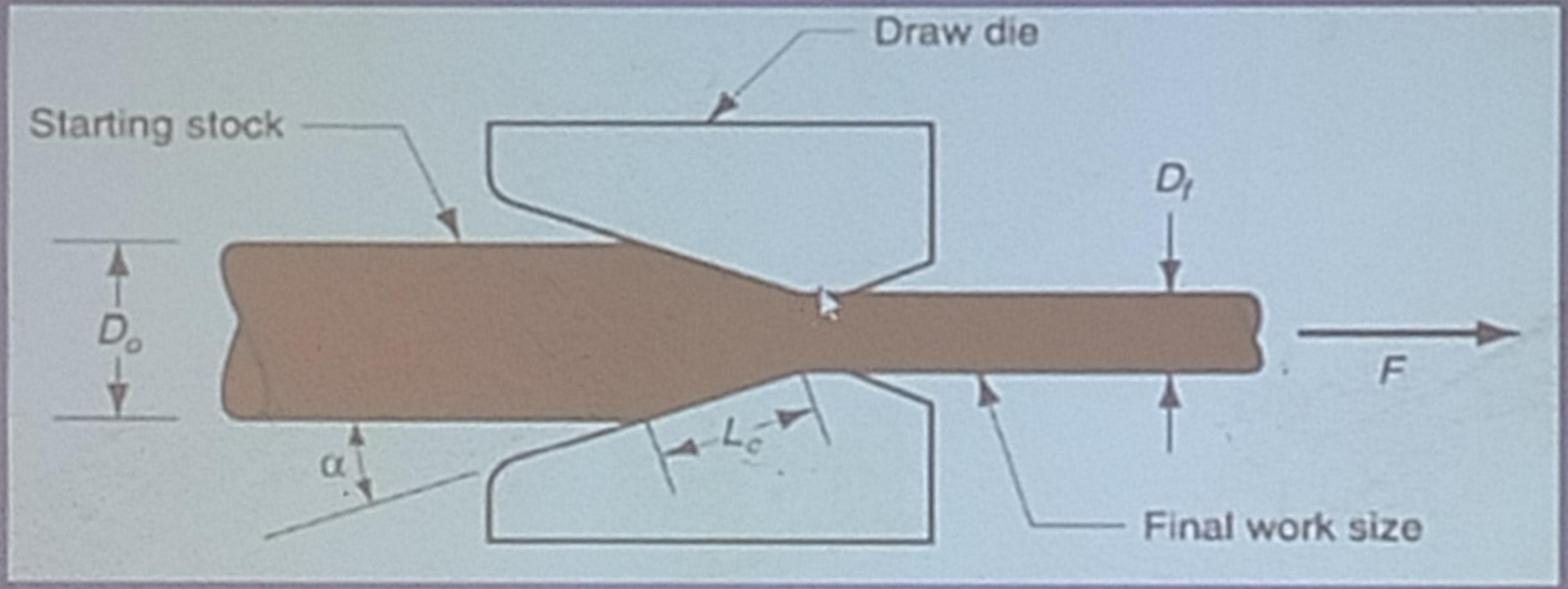
# Forming Processes - Drawing -

*Drawing* is the process most commonly used to make wires from round bars; this process is very similar to extrusion, except that instead of pressure from the back end, in drawing, the wire is pulled from the side where it emerges from the circular die.

Dies are made of specially hardened tool steels, or tungsten carbide. Diamond dies are used for drawing very fine wires. Drawing may be hot (the stock is heated to a high temperature for processing), or cold (the stock is not heated).

# Wire and Bar Drawing




Drawing of bar, rod, or wire.

# Area Reduction in Drawing

Change in size of work is usually given by **area reduction**:

$$r = \frac{A_o - A_f}{A_o}$$

where,

$r$ = area reduction in drawing;

$A_o$ = original area of work;

$A_f$ = area of final work;

# Maximum Reduction

Assume perfectly plastic material (n=0), no friction, no redundant work,

$$\sigma_d = \bar{Y}_f \ln \frac{A_o}{A_f} = Y \ln \frac{A_o}{A_f} = Y \ln \frac{1}{1-r} = Y$$

Then

$$\ln A_o/A_f = \ln 1/1-r = 1$$

$$A_o/A_f = 1/1-r = e$$

$$\varepsilon_{\max} = 1.0$$

The maximum possible area ratio $A_o/A_f = e = 2.7983$

The maximum possible reduction $r_{\max} = e - 1/e = 0.632$

# Mechanics of Drawing

Area reduction in drawing $r = \frac{A_o - A_f}{A_o}$ ; Draft $d = D_o - D_f$

No friction and true strain $\varepsilon = \ln \frac{A_o}{A_f} = \ln \frac{1}{1-r}$

The ideal stress $\sigma = \bar{Y}_f \varepsilon = \bar{Y}_f \ln \frac{A_o}{A_f}$

Taking into account friction and die angle, $\sigma_d = \bar{Y}_f \left(1 + \frac{\mu}{\tan \alpha}\right) \phi \ln \frac{A_o}{A_f}$

where $\phi = 0.88 + 0.12 \frac{D}{L_c}$ $D = \frac{D_o + D_f}{2}$ $L_c = \frac{D_o - D_f}{2 \sin \alpha}$

The drawing force $F = A_f \sigma_d = A_f \bar{Y}_f \left(1 + \frac{\mu}{\tan \alpha}\right) \phi \ln \frac{A_o}{A_f}$